The Dynamics of Mud Layers in Coastal Waters

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Award Number: N00014-03-2-4040
http://www.oceanica.ufrj.br

LONG-TERM GOALS

To improve our measurement capabilities, in lab or field conditions, in order to better understand the dynamics of fine sediments in coastal environments, regarding near bottom processes and flocculation as sediment accumulation process.

OBJECTIVES

To foster collaborative research between the Laboratory for the Cohesive Sediment Dynamics of the Federal University of Rio de Janeiro (LDSC/UFRJ), Brazil and other Universities and Research Centers.

To visit lab facilities for the study of wave-current boundary layers.

To know the site and more details about the Atchafalaya River Mouth experiment (references) and to discuss the viability of developing a similar experiment in some of the muddy environments in Brazil.

To discuss the format and to identify participants for the workshop ‘ Dynamics of Mud Layers in Coastal Waters’ to be held in Rio de Janeiro, in May 12-14, 2003, co-sponsored by ONR-IFO.

APPROACH

(a) Visit to V.T.Chow Hydrosystems Laboratory. The Large Oscillating Water-Sediment Tunnel was visited (see Figure 1) and was possible to have a short demonstration of the flow around a sand bed form under an oscillatory flow. This facility enables to reproduce the current-wave action in high turbulence conditions, which is a current limitation in regular wave canal experiments.

Figure 1: General view of the Large Oscillating Water-Sediment Tunnel (LOWST)

Other lab facilities of interest were visited, like the wave-current canal and the experiments about mine burial or the channel for stratified flow studies. Also, was possible to see the LISST instrument (Sequoia) for floc characterization working and to discuss about its use. The presentation in attachment (dunes.pdf) was shown in a meeting with the faculties and students of the Department.

(b) Visit to Boston College: Being Dr. Kineke one of the main researchers to participate in the Workshop on the Dynamics of Mud Layers in Coastal Waters to be held in Rio de Janeiro in May, 2003, the proposed program was discussed as well as the format of the event and of the proceedings. Aiming to better define a proposal in a similar environment in Brazil, the role of wave action on ressuspension, the role of mud in wave attenuation, and the positive feedback of wave-mud interaction were discussed regarding the experiments held in the Atchafalaya River Mouth. The main instrument used in the experiments at Atchafalaya site was an instrumented tripod, ‘gafanhoto’, which carries current meters, OBS, CTD and water sampler. Dr. Kineke also used this instrument during the Amasseds project in the Amazon Shelf. The data base of Amasseds experiment was extensively

analyzed by the visitor in a numerical modeling effort (Vinzon and Mehta, 2001, Vinzon and Paiva, 2002).

(c) Visit to the Navy Research Laboratory, Stennis SC. In order to know the activities developed at NRL related to coastal sediment dynamics seeking potential future collaborative projects, a presentation about our work on the Amazon Shelf (see attached file Mud and Hydro.pdf) was shown, and were held the following meetings: Nathaniel Plant and Jack Puleo about beach dynamics and the optical technique used for wave measurements, Yoko Furokawa about bioturbation and biological influence on flocculation, and Timothy Keen about sediment transport modeling. The projects in mine burial were also described.

(d) Visit to Louisiana State University. Following the objective to identify potential future collaborations the following meetings were held. Nan Walker showed their work in remote sensing for oceanography applications, mainly regarding to the current patterns in Gulf of Mexico. Gregory Stone and Alex Sheremet showed their work on wave-mud interaction and data acquisition (LSU WAVCIS CSI-3, see Figure 3 illustrating the sites). Sam Bentley presented his work on geochronology and on sediment burrowing. A day field trip to the Atchafalaya River mouth allowed the visitor to have an insight about the environment reported in the papers. Measurements of salinity and bottom samples were taken during the boat trip that comprehended a transect from the shore to the offshore place where the waves were markedly felt by the boat. A lesson from this visit was about the difficulties in measuring the near bottom layers. In the Paraiba do Sul River mouth, one of the possible environments to develop a similar experience, there is much less mud in the bottom deposit than in this environment, then, measuring near the bottom should be of special concern.

Figure 3: Platform where the instruments are fixed for wave, currents, suspended sediments etc. measurements.

(e) Visit to Hugo Rodriguez, Atlanta. The aim of this visit was to discuss his modeling approach for sediment transport in the coastal zone (long shore and cross shore), its strengths and weaknesses, and its applicability to the environment of Paraiba do Sul River mouth and others. The effect of mud on wave propagation, suitable rheological models, and boundary conditions were also discussed.

(f) Visit to University of Florida. Flocculation models currently used at the University of Florida were discussed as well as the use of the3-D hydrodynamic and sediment transport model available from EPA. The renewal of the cooperation agreement between UF and UFRJ was discussed with Prof. McDouglas.

TRAVEL COMPLETED

Table 1. Summary of visits conducted under this VSP.

Person Visited	Position	Institution / Conference	Location	Scientific / Technical Purpose	Dates
Marcelo Garcia	Professor Head of the Lab	University of Illinois	Urbana-Champaing, Illinois	Lab Visit	03/21-23/2003
Gail Kineke	Professor	Boston College	Boston, Massachusetts	Muddy Coast Dynamics	03/24/2003
Nathaniel Plant/Jack Puleo	Scientist	NRL	Stennis SC, MS	Sed Dynamics	03/26/2003
Tim Keen	Scientist	NRL	Stennis SC, MS	Sed Transport Modeling	03/26/2003
Yoko Furokawa	Scientist	NRL	Stennis SC, MS	Bioturbation /Flocculation	03/26/2003
Alexandru Sheremet/ Gregory Stone	Professor	LSU	Baton Rouge, Louisiana	Mud wave attenuation	03/27/2003
Nan Walker, Oscar Huh	Professor	LSU	Baton Rouge, Louisiana	Remote sensing in Oceanography	03/27/2003
Samuel Bentley	Professor	LSU	Baton Rouge, Louisiana	Geochronology Visit to field site	03/27-28/2003
Hugo Rodriguez	Scientist/ Consulting	Tetra Tech	Atlanta	Mud transport modeling	03/29-30/2003
Ashish Mehta	Professor	University of Florida	Gainesville, FL	Flocculation modeling	03/30-04/01/2003
W. McDougals	Professor	University of Florida	Gainesville, FL	UFRJ/UF cooperation agreement renewal	03/30/2003

RESULTS

(a) Visit to V.T.Chow Hydrosystems Laboratory. The following topics were identify being of mutual interest: (a) bed forms under current or under oscillatory flows, focusing flow resistance aspects; (b) wave-current boundary layer over muddy bottoms, focusing the damping of turbulence due to stratification and increased viscous effects; and (c) pipe burial in muddy beds. During this first contact two possible collaborations were stated: (1) A project in order to allow students from UFRJ, Brazil, to develop experimental work at the University of Illinois (lutocline formation under wave action, for example), and to allow researchers from UIUC to participate in field works in the Amazon River (2)

Formally include the UFRJ and the Amazon River works in the Large Rivers Group, head by Prof. Garcia and established in Santa Fe, Argentina.

(b) Visit to Boston College. One of the main challenges to study mud deposits in the coast is the measurement of its location and thickness, during the visit it was established the convenience of using the double frequency echo-sounder for this purpose. A meeting about the Amazon estuary was scheduled to be held on May 15, a day after the workshop, taking advantage of the presence of different groups involved in several projects in this area. The objective of this meeting is to know about the work of the different groups seeking future collaborative projects involving UFRJ and other groups in Brazil.

(c) Visit to NRL, Stennis SC. Two topics being developed at NRL were identified of interest: biological effects on flocculation and mud bearing strength in mine burial projects. As a result of the visit Dr. Tim Keen will participate in the workshop as speaker.

(d) Visit to Louisiana State University. The following topics were identified as of mutual interest: (a) radioisotopic geochronology, (b) burrowing effect on sediment stability, and (c) density profiling in the near bed layer using gamma radioactivity devices. Possible collaboration was set through student's exchanges (Brazilian 'sandwich' doctorate program) or in future research projects. As a result of this visit, Alex Sheremet will present his work on wave attenuation due to mud in the workshop.

(e) Visit to Hugo Rodriguez, Atlanta. A joint work was planned during the visit about the importance of mud wave attenuation versus wave dissipation and its role on the different behavior of short and long waves in the presence of muddy bottoms. The application of his model to the Guyana coast will be discussed during the workshop, where he was invited as one of the speakers.

(f) Visit to University of Florida. Collaborations between UF and UFRJ have been established since 1994. The visit reinforced our links.

IMPACT/APPLICATIONS

The LDSC is a new laboratory and unique in Brazil. International collaboration will strongly help its development.

TRANSITIONS

Cohesive sediment dynamics is a subject with a strong demand. The development of the lab/field measurement facilities and knowledge in this subject will help to solve problems concerning contaminated sediment dredging, pipe crossing muddy bottoms, sedimentation in harbors, etc.

RELATED PROJECTS

CAPES/COFECUB, Hydrodynamic and Sediment Transport Modeling of Amazon River, 2002/2003.

Flocculation of Fine Sediments in Fresh and Estuarine Environments CNPq Project, 2002/2003.

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PUBLICATIONS

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